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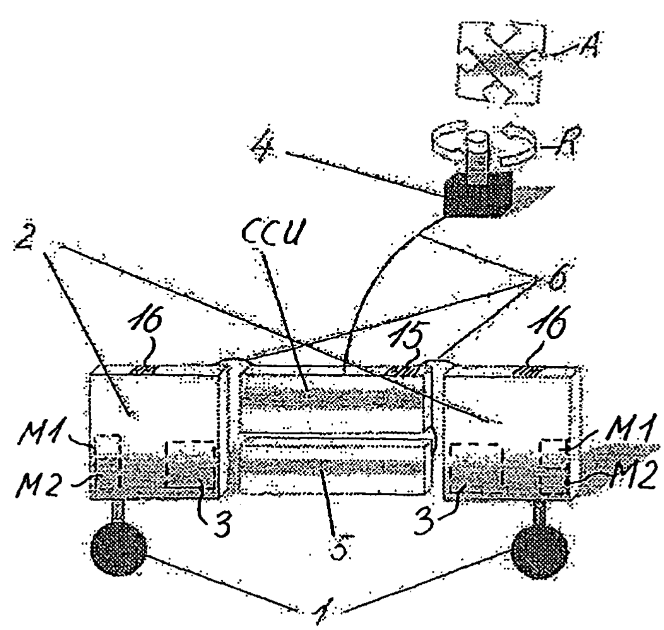
(54) Title: A MODULAR DRIVE WHEEL SYSTEM



(57) Abstract: A modular drive wheel system is used for supporting and driving an object so as to provide a power driven vehicle. The wheel system comprises two or more wheeled units or bogies (2) adapted to be mounted at selected locations of the object to support the same. Each unit or bogie (2) comprises one or more wheel members (1) mounted in the unit so as to be rotatable relative thereto. Motors (M) for rotating each wheel member of the unit and for steering the wheel member(s) of the unit or bogie in desired directions. The system further comprises a programmable central control unit (CPU) or microcomputer and a programmable electronic bogie control device (3) arranged at each of the wheeled units or bogies (2) for controlling the function of the driving and steering motors (M) of the wheeled unit(s) (2). Preferably, the central control unit and the bogie control devices (3) are galvanicly isolated, for example by means of optocouplers, and the control unit (CPU) may comprise means for transforming output command signals to be transmitted to the bogie control devices at the wheeled units or bogies into serial digital strings, whereby information may be transferred to the bogie control devices, for example via optocouplers (25), with high efficiency. Such modular system may be marketed as a standard wheel system for rendering any object, such as a load carrying platform or a vehicle, including wheeled hospital beds, self-propelling and extremely manoeuvrable.

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A MODULAR DRIVE WHEEL SYSTEM

FIELD OF THE INVENTION

The present invention relates to a wheel system for supporting and driving an object, with or without wheels, for example a pallet or a vehicle, such as for example wheelchairs, pallet movers, hospital beds or even industrial robots.

BACKGROUND OF THE INVENTION

Power driven wheels have long been used to assist in the transport of vehicles. Vehicles fitted with traditional wheels, however, suffer from a number of disadvantages, the main one being that they are quite cumbersome to manoeuvre and cannot negotiate a twisting pathway that could, for example, easily be negotiated by a person on foot. Most power driven vehicles manoeuvre similarly to for instance a car. This means that in order to go for example to the left, the vehicle needs a lot of space for turning.

A more efficient way of going i.e. to the left would be for the vehicle to be able to move sideways without turning the vehicle itself. A number of omni directional drive wheels and wheeled assemblies have been developed in order to allow vehicles to negotiate paths, which would otherwise not be practicable with traditional wheels, including going sideways and/or turning around the vehicle's own centre point (e.g. WO 99/01298, WO 93 20791A, US 4,519,466, WO 91/18577 & US 4,995,679A). The most conspicuous similarity between all these wheels is that they are mounted on a shaft or support member which can be rotated, allowing for unlimited turning of the wheel's direction, the general idea being that first the wheel is turned to point in the desired direction, then the drive engine is activated and the vehicle will move in the desired direction without having to turn, i.e. making the vehicle omni directional. In some instances all the wheels on the vehicle are drive wheels, in others only some of the wheels are drive wheels the rest being freely swivelling wheels.

All the known drive wheels and wheeled assemblies with the above characteristics share the feature that in order to be mounted on any given vehicle, considerable structural changes have to be made to the vehicle itself. This makes fitting such omni directional drive wheels onto existing wheeled vehicles cumbersome and in many instances impossible. Furthermore, fitting the known systems onto a vehicle requires substantial understanding of accurate control of the turning as well as translational movement of the wheels in accordance with the required drive geometry. Considerable consideration must be given to the man/machine interface in relation to the physical structure and the required drive geometry.

Although the advantages of having a power driven omni directional wheeled vehicle are widely recognised for vehicles as different as wheelchairs, patient hoists, shower chairs, commode chairs, transport chairs, walking aids, forklifts, palette movers, work tables, robots, distribution trolleys, mobile work platforms, luggage trolleys, shopping trolleys, hospital beds, hospital cabinets, hospital waste containers, construction vehicle, earth moving vehicles, mining vehicles, and bomb disposal vehicles extremely few such power driven omni directional vehicles are available on the market. This fact is believed to be due to the difficulties encountered when installing and controlling the existing omni directional power driven wheels.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention provides a drive wheel system or a drive wheel set for supporting and driving an object, said wheel system comprising:

at least two separate wheeled units or bogies to be mounted at selected locations on the object to support the same, each unit including a frame, at least one wheel member rotatably mounted in relation to the frame, driving means for rotating the wheel member(s) in relation to the frame, and steering means for moving the wheel member(s) in desired directions in relation to the frame, and

electronic control means for controlling the function of the driving and steering means of said wheeled units or bogies and including a pre-programmed bogie control device at each said wheeled units or bogies, signal transmitting means, and a pre-programmed central control unit for outputting command signals to each of the pre-programmed bogie control devices via the signal transmitting means in response to input command signals received.

Thus, the present invention provides a modular kit, which may comprise driving wheeled units or bogies, power supply means, such as a power pack, and electronic control means, and which is adapted to be mounted on a broad variety of wheeled vehicles, such as wheelchairs, pallet movers, hospital beds or even industrial robots.

The division of the electronic control means into a pre-programmed central or common control unit or microcomputer, which is common to all of the wheeled units or bogies, and pre-programmed bogie control devices or microcomputers arranged at a wheeled unit each involves important advantages. Thus, data processing requiring high data transmission rates may take place inside the central control unit and the bogie control devices, respectively, while the data transmission rate between the central unit and the various bogie control devices via the data transmission means may be kept suitably low.

By arranging the drive wheel system such that only raw power and high level, low rate data transmission to each single wheeled unit from a power source and from the central control unit, respectively, are required, true modularity and operational safety may be obtained. Furthermore, the central control unit may comprise first programming means for inputting information about the mutual positions of the wheeled units or bogies on said object and/or each bogie control device may comprise second programming means for inputting information about the orientation of the associated wheeled unit in relation to a selected common axis when mounted on said object. The first and second programming means may, for example, comprise simple digital switches, so that persons without expert knowledge may install and program the drive wheel system according to the invention on a selected object based on simple written or oral instructions.

The invention renders it possible to use a standard drive wheel system for rendering any object, such as a load carrying platform or a vehicle, including wheeled hospital beds, self-propelling and extremely manoeuvrable. Thus, the object may be provided with two or more wheeled units or bogies, and the operation of these units are co-ordinated by the central control unit, regard being paid to the individual and relative positions of the wheeled units or bogies on the object.

To applicant's knowledge, no such self-contained, ready-to-use, pre-programmed, modular power driven omni directional drive systems have been described in literature. As indicated above, the system according to the invention allows vehicle manufacturers with no or little understanding of power driven omni directional wheels, engines, electronics, software and drive geometry to render their vehicles omni directional, simply by mounting the modular system onto the vehicle. Furthermore, such a system also allows owners of existing manually driven vehicles to render their vehicles power driven and omni directional in a very simple manner.

The drive wheel system according to the invention may further comprise a command device for inputting command signals to the central control unit, whereby an operator can control the movement of the wheeled object or vehicle. Such command device may, for example, comprise a manually operable steering device, such as a joystick, a steering wheel and/or one or more steering levers, or a system of force transducers.

The central electronic control unit may be handheld, for example together with the command device or steering device. Preferably, however, the control unit is mounted on the object. Alternatively or additionally, the command device may comprise a wireless

remote control, such as e-mail or mobile phone. Such remote control may also be used to monitor, diagnose, or re-program individual modules or the total drive wheel system.

Alternatively or additionally, the electronic control unit may be pre-programmed so that the wheeled object may be driven along a selected path in accordance with such pre-selected program so that no manual steering is necessary.

In order to obtain correct steering movements of the wheel members the central electronic control unit is preferably programmed to ensure that the steering means are moving all wheel members of the wheeled units or bogies mounted on the said object in such a manner that at any time during driving, all wheel members are either moving along substantially parallel paths or along concentric arcs of circles.

In principle, the signal transmitting means could merely be in the form of wires or electrical conductors. However, in order to prevent possible ground loops passing unintended loop currents, which might corrupt the proper functioning of the total system, the signal transmitting means preferably comprise a galvanic isolating device. Such device may, for example comprise an optocoupler. An optocoupler is a device or chip comprising a light source (typically a LED) emitting light to a photo sensor when activated. The photo sensor may be a photo diode or a transistor, which is activated when hit by light from the light source. Because the electrical connections of the light source and the photo sensor may be widely separated on the chip, galvanic separation between these two components to a high voltage level may be obtained.

Preferably, the central control unit comprises means for transforming output command signals to be transmitted to the bogie control devices at the wheeled units or bogies into serial digital strings, whereby information may be transferred to the bogie control devices, for example via optocouplers, with high efficiency.

From the above it is clear, that an optocoupler can transfer information encoded as a digital serial string with high efficiency. At the same time, the device ensures complete galvanic separation of the communicating circuits on either side of the optocoupler, thereby preventing possible ground loops passing unintended loop currents, which might otherwise corrupt the proper functioning of the total system. This is an important aspect in a system intended for high reliability while maintaining freedom of location of the bogie modules in an overall assembly design, particularly in the case of a user without specialized electronic knowledge.

It should be understood that according to the present invention the electronics of the electronic control means could advantageously be divided into the central control unit on one hand and each of the bogie control devices on the other hand so as to minimize data transmission via the signal transmitting means.

In order to make use of an isolating device that is specifically capable of uni-directional or bi-directional transfer of digital data on serial format, it is fundamentally necessary, that data handling capability is to be present on either side of such isolating device, with suitable programs encoded to transform commands of whatever form into serial digital strings and visa versa.
The microcomputer(s) in the central control unit is/are arranged to transform joystick or similar manual inputs into data strings prescribing bogie movements in terms of wheel speed and wheel direction as requested to achieve the overall response of the total mobile unit. The command bandwidth for communication at this level of is not very demanding and consequently the required data rate is not very high.

The microcomputer(s) in each wheeled bogie is/are arranged to transform the received data strings, prescribing overall bogie movement, into the closed loop control commands handling very precisely wheel direction and wheel rotation movements and the mutual relations between these, while at the same time being exposed to external disturbances in the form of sudden translent load variations etc. to accurately achieve the prescribed bogie movement. This involves rather high data rates, which can thus be kept internal, locally in each bogie control device and need not be communicated to the overall central control unit.

The driving and steering means of the wheeled units or bogies may comprise motors selected from the group consisting of electric motors, hydraulic motors, pneumatic motors, steam engines, thermodynamic engines, and combustion engines.

In principle, the wheeled units or bogies of the drive wheel system according to the invention may be different in various aspects. Preferably, however, the wheeled units or bogies of the system are substantially identical. Apart from the electronic bogie control device the wheeled unit may be of any omni directional type, such as those disclosed in the above patent publications. Preferably, however, each wheel member of the wheeled units or bogies is of the type comprising a support member, a wheel element and a drive shaft, the drive shaft having a drive means engaging a drive surface on the wheel element to rotatably drive the wheel element relative to the support member, the drive shaft having a longitudinal axis and the engagement of the drive means and drive surface defining in vertical cross-section a line of engagement that is at an acute angle to the

longitudinal axis, the wheel element having a surface contacting portion extending about its periphery and positioned such that it is intersected by the line of engagement substantially at where it contacts a supporting surface.

According to another aspect, the present invention provides a method of rendering an object self-propelling by means of a drive wheel system of the type described above, said method comprising:

mounting at least two of said wheeled units or bogies on the object at selected locations thereof and with selected orientations in relation to a certain direction,

programming said first programming means by inputting information about the mutual positions of the wheeled units or bogies on said object,

programming said second programming means by inputting information about the orientation of the associated wheeled unit in relation to a selected direction, and

inputting command signals to the central control unit by means of the command device so as to move the vehicle along a desired path.

The wheeled units or bogies may be installed at any selected suitable location, and information to be encoded into the central control unit about the mutual positions of the wheeled units or bogies may be based on the positions in relation to an actual or imaginary co-ordinate system fixed with respect to the object on which the system is to be installed. In such case the said selected direction may be one of the axes of the co-ordinate system.

The electronic control means are preferably pre-programmed to ensure that the steering means are moving all wheel members of the wheeled units or bogies mounted on the said object such that any time during driving, all wheel members are either moving along substantially parallel lines or substantially concentric arcs of circles.

The object to be rendered self-propelled may be a manually driven vehicle having a plurality of supporting wheels, at least some of these wheels being replaced so as to have the vehicle supported by at least two of said wheeled units or bogies and freely swivelling wheels or casters, only.

Apart from transmission of raw power, the wheel system according to the present invention only requires high level, low rate data transmission from the central control unit to the bogie control devices at the respective wheeled bogies, whereby true modularity and operational safety is obtained in a manner, which does not require specially trained persons.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be further described with reference to the drawings, wherein Fig. 1 diagrammatically illustrates an embodiment of the drive wheel system according to the invention,

Fig. 2 is a sectional view of a preferred drive wheel to be used in connection with the present invention,

Fig. 3 -8 diagrammatically illustrate an embodiment of the drive wheel system according to the invention and various operational steps,

Fig. 9 illustrates a pallet mover, on which the modular drive wheel system shown in Figs. 1-8 has been mounted,

Fig. 10 illustrates a hospital bed with the drive wheel system shown in Figs. 1-8 mounted thereon.

Fig. 11 is a simplified representation of a chassis provided with a drive wheel system according to the invention, for example a person hoist,

Figs. 12 and 13 are a representation of the motion geometry of the wheeled chassis shown in Fig. 11,

Fig. 14 is a block diagram showing an embodiment of the central control unit of the wheel drive system, and

Fig. 15 is a block diagram showing an embodiment of an electronic bogie control device arranged at each of the bogie modules or wheeled units.

DESCRIPTION OF PREFERRED EMBODIMENT

Fig. 1 diagrammatically shows an embodiment of the drive wheel system according to the invention in the form of a modular system or kit. Thus, the system comprises two or more (in Fig. 1 two are shown) wheeled units or bogie modules 2 each having at least one omni directional drive wheel 1. Each module 2 further includes a directional motor M1 and drive motor M2 diagrammatically indicated by dotted lines, and a power pack module 5 for supplying power to the motors M1 and M2 via connecting cables 6. The operation of the wheeled bogie modules 2 is controlled by means of a central control module or unit CCU or microcomputer provided with suitable software, and by means of a man/machine interface, such as a joystick 4, from which control input signals may be sent to the central control unit CCU. Control output signals from the central control unit CCU are transferred to a pre-programmed electronic bogie control device 3, such as a microcomputer, at each of the bogie modules 2. The drive wheel system shown in Fig. 1 may be mounted on any given object without wheels, or on a vehicle so as to replace all wheels thereon not being freely swivelling wheels, whereby the vehicle is rendered omni directional. Non-freely swivelling wheels should be replaced either by wheeled bogie modules according to the invention or by free swivelling wheels or caster wheels. The bogie modules 2 can be mounted directly

on a vehicle using traditional fastening means and methods, possibly via mounting brackets 10 (Fig. 9).

Depending on the size, nature and weight of the object or vehicle, which one wants to render power driven and omni directional according to the present invention, the size and type of the omni directional drive wheel(s) of each bogie module may be varied. Similarly, the type and torque of the motors or engines chosen for controlling direction and for driving may be varied. Thus, for small or light vehicles electrically powered motors may be ideal, while combustion engines, hydraulic or pneumatic engines might be preferred for heavy vehicles.

As an alternative to the power pack module 5, power may be supplied to the drive wheel system from external sources or under circumstances kept in storage in the wheeled bogie module 2 itself.

A suitable number of the said wheeled bogie modules 2 may be mounted on any given vehicle at any location best suited to the specific requirements of the vehicle in question. Subsequently, the central control unit CCU must be informed of the position of each wheeled bogie module 2 on the vehicle. In practical applications, the central control unit CCU will have to be encoded with the co-ordinates of each bogie module 2 on the mobile chassis, and each bogie module 2 must be encoded with its orientation relative to the co-ordinate system of the mobile chassis. For this purpose, suitable programming means, such as digital switches 15 and 16 (indicated in Fig. 1) may be provided on the bogie control devices 3 and on the central control unit CCU, respectively. Once this information has been defined and stored in the central control unit CCU and the bogie control devices 3 has been provided with information about their orientation as described below, the modular omni directional power drive system is ready for use.

The man/machine interface module 4 can take a number of forms depending on the vehicle in question. The function of the man/machine interface module 4 is to translate the steering commands given by the vehicle operator into steering information for use by the wheeled bogie modules 2. Possibilities could be wheel and throttle levers or pedal combinations, diverse levers for longitudinal and athwart (fore and aft) control or two or three axis versions of joystick controls. For unmanned vehicles, remote control systems of a wide variety could be used to communicate with the central control unit CCU.

Whichever way the control unit CCU would transmit individual commands to the wheeled bogie modules 2 related to the location of each module fitted on the vehicle, a co-ordinated movement in the horizontal plane of the total vehicle is achieved. The object or

vehicle could be combined of two or more mutually articulated or telescopically interconnected subunits each provided with one or more bogie control device(s) 2 and the central control unit CCU may then control the movement of each bogie so as to obtain movement of the total vehicle including mutual movement of the subunits. Communication between the control unit CCU and the bogie control devices 3 of the wheeled bogie modules 2 can take place via connecting cables 6, via radio signals or whichever form of communication is best suited to fit the vehicle in question.

As already mentioned, the power pack module 5 may be a separate unit or under circumstances be contained in one or more of the wheeled bogie modules 2. Alternatively, it may be united with the central control unit CCU, which in itself may be a self-contained unit or be part and parcel with the man/machine interface module 4. In certain cases the power required may already be part of the drive vehicle itself and thus not be required as a new item to be added to the drive vehicle.

Likewise, the control unit CCU may be a unit in its own right or - more preferred - it may be united with the man/machine interface 4, as the function of these two units are closely related. As already discussed, the man/machine interface 4 may appear in many different versions, intimately related to the configuration and functional purpose of the vehicle in question.

If the vehicle is of a fixed shape easily overlooked by a co-moving operator or driver, a three-axis joystick with the two tilting movements controlling the translational movements of the vehicle and the rotation of the third axis controlling the rotational movement could be ideal. However, a configuration consisting of a two axis joystick side by side with a knob or wheel controlling rotation can be very convenient, particularly if the operation of the vehicle calls for initial orientation of the vehicle by means of the wheel, then locking the rotational control onto some automatic means of heading control, leaving the operator free to concentrate fully on the translational movements of the vehicle in close vicinity to some fixed or moving obstacle. The translational motion control may, if relevant, likewise be hooked up to some automatic following a fixed or moving reference.

Fig. 2 illustrates a presently preferred drive wheel 110 to be used in the wheel bogies of the present invention and of the type disclosed in US patent No. 6,474,434, which is hereby incorporated herein by reference. It should be understood, however, that any other similar omni directional drive wheel could be used.

This drive wheel 110 includes a wheel member 111 capable of rotating relative to a support member 112 about an axle that is fixed to the support member 112 by a

screw115. The wheel member 111 has a frusto-spherical outer surface 113 and first and second end surfaces 116 and 117, respectively. An elastomeric tread 118 extends around the periphery of the wheel member 111 adjacent to the first end surface 116. A curved outer surface of the tread defines a rolling line 128 that contacts the ground surface 119 over which the wheel member 111 travels when in use.

A tubular steering or support shaft 122 extends downwardly from the bogie module 2 rotatably mounted in bearings 120, which are arranged between the bogie 2 and the support member 112. A drive shaft 124 is mounted concentrically within the tubular steering or support shaft 122 by means of bearings 123. The drive shaft 124 may be rotated by the drive motor M2 diagrammatically indicated in Fig. 1. Similarly, the steering shaft 122 may be rotated by the steering motor M1 (Fig. 1).

The free end of the drive shaft 124 adjacent to the wheel member 111 has a bevel pinion 125 engaging with a crown wheel 126 mounted on the end surface 116 of the wheel member 111. As shown in the sectional view in Fig. 2, the pinion 125 and the crown wheel 126 defines a line of engagement 127 that is at an angle to the longitudinal axis 124a of the drive shaft 124. Accordingly, when the drive shaft 124 is rotated about its longitudinal axis 124a by the drive motor M2 under the control of the central control unit CCU and the bogie control device 3 at the bogie 2, the wheel member 111 is rotated relative to the support member 112 and so that the wheel member 111 is driven over the ground or floor surface 119. The curved outer surface of the wheel tread 118 is intersected by the line of engagement 127 of the gears 125, 126 at the rolling line 128.

Figs. 3 – 8 disclose only one embodiment of the modular components of the system according to the invention. Thus, in all these Figures the man/machine interface module 4 is shown as a 3-axis joystick, but it could be any of the alternatives described above. While the system according to the invention may be mounted on an infinite variety of different objects or wheeled vehicles, the invention is assumed to be mounted onto some kind of vehicle (not shown) having only free swivelling wheels or casters of its own.

In Fig. 3 the joystick has been pushed to the right as indicated by arrow A causing both wheels 1 on the two wheeled bogie modules 2 to be turned towards the right a, b. Then the motors or engines M2 are activated, and the entire vehicle will move to the right as indicated by an arrow D.
In Fig. 4 the third axis knob on joystick is turned clockwise as indicated by an arrow R, whereby the steering motors M1 causes the wheels 1 on the two wheeled bogie modules 2 to orientate themselves at mutually oblique angles relative to the athwart direction of the vehicle a, b. Then the drive motors M2 are activated, and the entire vehicle will rotate

clockwise around a centre of rotation as indicated by arrows C and identified by the angular orientation a, b of each of the two wheels 1.

In Fig. 5 the third axis knob on joystick is turned counter clockwise as indicated by the arrow R causing the wheels 1 on the two wheeled bogie modules 2 to orientate themselves at mutually oblique angles relative to the athwart direction a, b of the vehicle. Then the drive motors M2 are activated, and the entire vehicle will rotate counter clockwise around a centre of rotation identified by the angular orientation a, b of each of the two wheels.

In Fig. 6 the joystick is pushed to forwards (arrow A) causing both wheels 1 on the two wheeled bogie modules 2 to be turned parallel to the longitudinal direction a, b of the vehicle. Then the drive motors or engines M2 (Fig. 1) are activated, and the entire vehicle will move forwards.

In Fig. 7 the joystick is pushed backwards as indicated by the arrow A causing the steering motors M1 (Fig. 1) to turn both wheels 1 on the two wheeled bogie modules 2 parallel to the longitudinal direction a, b of the vehicle. Then the drive motors or engines M2 are activated, and the entire vehicle will move backwards as indicated by the arrow D.

In Fig. 8 the joystick is pushed backwards at an oblique angle as indicated by the arrow A causing both wheels 1 on the two wheeled bogie modules 2 to be turned mutually parallel at the same oblique angle (indicated by arrow D) as the joystick relative to the longitudinal direction a, b of the vehicle. Then the drive motors M 2are activated, and the entire vehicle will move in that same oblique direction.

In Fig. 9 the modular system according to the invention is mounted on an undercarriage 9 of a stylised pallet mover 7 with freely swivelling front wheels 8, and both wheeled bogie modules 2 are mounted at the rear end of the pallet mover by means of mounting brackets 10. The lifting fork of the pallet mover 7 and the stylised hoisting mechanism 11 are shown for completeness. The driving characteristics of the vehicle illustrated in Fig. 9 are as illustrated in Figs. 1 - 7 and as described in connection therewith.

In Fig. 10 the system according to the invention is shown mounted underneath a stylised hospital bed with two freely swivelling wheels or casters 8. In this example the wheeled bogie modules 2 are fitted at diagonally opposite corners of the bed to illustrate the freedom of mounting of the wheeled bogie modules on the vehicle in question subject to the one proviso that the actual location of each wheeled bogie module is fed into the storage memory of the central control unit CCU as explained later more in detail. The

entire driving characteristics of the vehicle illustrated in Fig. 10 will then again be explained above end as illustrated in Figs. 1 - 9.

One or both of the two freely swivelling wheels 8 on the stylised hospital bed in Fig. 10 may be substituted by additional wheeled bogie modules 2 with the one proviso that the actual location of each additional wheeled bogie module is likewise fed into the storage memory of the central control unit CCU.

In principle, any desired number of wheeled bogie modules 2 according to the invention may be mounted on an object or vehicle.

PRINCIPLES OF DRIVE CONTROL

Fig. 11 is a simplified representation of an object or a chassis, which has been rendered omni drivable by mounting a drive wheel system according to the invention thereon. Thus, the chassis shown has been provided with two bogie modules 2 each having a drive wheel 110 and two standard non-driven, freely swivelling wheels 130. The chassis shown in Fig. 11 is capable of undergoing change in lateral dimension simply by a movement of the respective drive wheels either relatively towards or away from each other. In this embodiment, the chassis can be considered composed of two sub-carriages 131 having lateral members 132 that can telescopically or otherwise move with respect to each other. Mutual movement of the sub-carriages may be obtained simply by driving the two drive wheels 110 either towards or away from each other thereby allowing the lateral dimension of the chassis to be adjusted. In the arrangement depicted in Fig. 11, the lateral members 132 may move so as to ensure that the respective distances of the drive wheels 110 from a central linking housing 133 remain symmetrical relative to the housing 133. The capability of the chassis to adjust its lateral dimensions can be particularly useful when the chassis has to pass through a narrow opening, such as a door opening. Fig. 11 gives an example of a reference co-ordinate system and axis orientation for translatory motion and rotation.

When a drive wheel system according to the invention has been mounted on an object or vehicle to be rendered self-propelling, the central control unit CCU controlled by joystick commands, as well as the bogie control devices 3 (Fig. 1) at the bogie modules 2 have to be programmed in order to obtain a correlated function of the various parts of the system. For this purpose it is useful to utilise an imaginary co-ordinate system located in a plane parallel to the ground or floor surface 119 (Fig. 2) so that the axis of abscissas or x-axis defines the forwards/backwards movement while the ordinate axis or y-axis defines the transverse or sideways movement of the chassis relative to an arbitrary reference point. In

Fig. 11, forward movement from the reference point is considered movement in a positive direction along the x-axis and sideways movements to the right from the reference point is considered movement in a positive direction along the y-axis. Any rotation about the reference point is considered positive if the rotation is clockwise when viewed from above.

As indicated above, the chassis exemplified in Fig. 11 may telescopically change its width. This width variation is termed SHIFT and is obtained purely by wheel control without any internal telescope drive, merely referring to a mechanical link (or roller chain and sprockets) to ensure symmetry of the two sub-carriages 131 relative to the central body 133. The necessary feed back information to the control unit may, for example, be derived from one of the sprockets.

For the purpose of understanding the operation of the drive motor M2 and the steering motor M1, reference will be made to the following definitions:

SYMBOL	DESCRIPTION	DIMENSION
Jx	Joystick X-command, normalised.	m/s
Jy	Joystick Y-command, normalised.	m/s
ω	Joystick turn command, normalised.	rad/s
U	Joystick speed command, normalised.	m/s
Wx	Wheel X-co-ordinate	M
Wy	Wheel Y-co-ordinate	M
VW	Wheel speed command	m/s
VWx	Wheel speed X-command	m/s
VWy	Wheel speed Y-command	m/s
φ	Joystick deflection direction	Radian
ψi	Wheel direction command	Radian
S'y	K1(Wyi - Wyo) . SHIFT of Wx and Wy.	m/s
K1	Shift time constant	s-1
K2	Rate feed forward	Nondim
K3	Proportional gain	s-1
K4	Wheel offset	M

The general movement of a drive carriage can be described at any given moment as a rotation about some point in the ground surface, or as the linear superposition of a movement of pure translation and a rotation about the reference point. From this the motion geometry appears from Figs. 12 and 13, and the following control equations follow:

$VWx = Jx - \omega Wy$

$VWy = Jy + \omega Wx + s'y$

$$V_W = \sqrt{(U\cos\varphi - \omega W_y)^2 + (U\sin\varphi + \omega W_x + s'_y)^2} = \sqrt{(J_x - \omega W_y)^2 + (J_y + \omega W_x + s'_y)^2}$$

$$\cos\psi_i = \frac{U\cos\varphi - \omega W_y}{V_w} = \frac{J_x - \omega W_y}{V_w}$$

$$\sin\psi_i = \frac{U\sin\varphi + \omega W_x + s'_y}{V_w} = \frac{J_y + \omega W_x + s'_y}{V_w}$$

CENTRAL CONTROL UNIT

Figure 14 is a schematic block-diagram of an embodiment of the central control unit CCU. The control unit illustrated in Fig. 14 comprises three signal transmitters indicated by 20 associated with the tri-axial joystick 4, namely an X-potentiometer for the longitudinal command, an Y-potentiometer for the athwart command, and an ωp-potentiometer for the rotation command.

The central control unit further comprises a Wx-potentiometer for manual setting of the Wx-coordinate and a Wyo-potentiometer for the feedback of the actual Wyo-coordinate as measured by the telescopic movements between the two drive bogies. All the values are subject to ADC-conversion and subsequent scaling to obtain identifiable dimensional values. The scale factors are saved in a memory when the circuit is off power. After the digital scalers, the corresponding values Jx, Jy and ω appear on normalised form independent of individual joystick tolerances. The joystick speed components Jx and Jy are now combined to the normalised joystick speed command U. From these values sinφ = Jy/U and cosφ = Jx/U are obtained subject to U>0.

The two values U and ω are now modified through scale factors to obtain suitable full scale deflection speeds in accordance with the operator's requirement. Similarly the command values are subject to maximum acceleration and deceleration restrictions through selectable filters.

These modified values are U' and ω'. Subsequently, the modified command components J'x = U'cosφ and J'y = U'sinφ are obtained, which method ensures simultaneity between the two vector components J'x and J'y . Selectable damping routines to the input commands are applied to the values J'x = U'cosφ and J'y = U'sinφ together with the rotation command

ω' at this level. An integrator stores the output value Wyi, which is the instantaneous command value for the athwart distance Wyo of each drive wheel from the centre line.

During start up of the system this integrator is initialised with Wyo = Wyi in order to ensure bump free start up of the system. During operation the integrator accepts input commands from the two push buttons SHIFT-WIDE and SHIFT-NARROW in Fig. 14 to increase or decrease the value of Wyi. The value Wyo represents the distance of each drive wheel from the centre line of the drive chassis and is to be taken as positive for the right hand drive wheel and negative for the left hand wheel.

The difference between the two is used to generate the correction $s'y = K1(Wyi - Wyo)$, which is added to the commands from the joystick in the athwart direction to the wheel control. This causes the wheels to approach the required distance between them in an exponential manner with a time constant equal to K1 if the bandwidth of the subsequent control system is sufficiently larger than 1/K1.

The remaining motion commands originate directly from Joystick manipulations generating the two vector components J'x and J'y as well as ω', which combine with the shift command in accordance with the above formulae to generate the two wheel command vectors: $VWx = J'x - \omega' Wy$ (longitudinal direction) and: $VWy = J'y + \omega' Wx + s'y$ (athwart direction). This set of wheel commands is generated separately for each bogie, and differs for each bogie in relation to the different wheel co-ordinates in the overall chassis coordinate system. From the root of the sum of squares of these two command vectors is derived the drive wheel command speed VWi (always a positive number).

Each of these vectors divided by VWi subject to VWi > 0, generate sinψi and cosψi where ψi is the input command angle for the wheel drive direction in the overall chassis coordinate system. The values VWi subject to VWi > 0, sinψi and cosψi are generated by the central control unit with reference to the overall chassis coordinate system for each of the active bogies and transmitted on digital form to each bogie together with the normalized chassis rotation command ω'.

These signals are preferably transmitted from the central control unit CCU to each of the bogie control devices 3 via an optocoupler transfer 24 for galvanic separation of the central control unit CCU and the bogie control devices 3, respectively. Likewise, monitoring information may be re-transmitted from each of the bogie control devices 3 back to the central control unit via similar optocouplers (not shown).

BOGIE CONTROL DEVICE

The mathematical model of Wheel Turn will now be described with reference to Fig. 15, which is a diagrammatic illustration or a block diagram of the electronic bogie control device 3 arranged at each bogie unit 2. The wheel turn part of Fig. 15 defined by a dotted line frame is indicated by 21 and comprises mainly of two integrators executing the following two relations:

$$\sin\psi_m = \int \dot{\psi}_m \cos\psi_m dt$$

$$\cos\psi_m = -\int \dot{\psi}_m \sin\psi_m dt$$

subject to radius normalization.

The input command to this model is the value $\dot{\psi}_m$ (required model rate of turn) generated in the Angular Difference Group 22. The terms to be integrated are generated by the input rate of turn and the output values of the model, cosψm and sinψm, respectively. The root of the sum of the squared output values is used to maintain the integrator outputs on a unity radius value. Thus, the whole block thus constitutes an unlimited circular integrator of the input value $\dot{\psi}_m$. The two integrators can, when required and particularly at power-up, be initialised with the values cosψo and sinψo, representing the actual angular position of the physical drive wheel housing. The purpose of this mathematical model is to obtain a controlled rotation of the physical drive wheel housing, with a known and noise-free value of $\dot{\psi}_m$ irrespective of any external disturbances of the physical drive wheel housing.

The physical drive wheel housing is subsequently locked on to the mathematical model through a servo control loop 23, the details of which are shown in Fig. 15. The input command value to this servo is the sine of the angular difference between the physical drive wheel housing and the mathematical model given by sin(ψm - ψo) = sinψm cosψo - cosψm sinψo. The gain coefficient K3 controls the bandwidth of this loop, which must be significantly larger than what results from the maximum rate of turn permitted into the mathematical model of wheel direction.

The feed-forward of $\dot{\psi}_m$ through the coefficient K2 ensures, that the dynamic value of sin(ψm - ψo) is always small, K2 having a value matching the required servo input for the rate of turn in question. Thus, the correspondence between the physical drive wheel housing and the mathematical model is always very good up to the torque limit of the wheel turn servo motor.

THE ANGULAR DIFFERENCE GROUP

This group consists mainly of the four multipliers evaluating the terms:

$\sin(\psi i - \psi m) = \sin\psi i \cos\psi m - \cos\psi i \sin\psi m$
$\cos(\psi i - \psi m) = \cos\psi i \cos\psi m + \sin\psi i \sin\psi m$

which identify the angular difference ($\psi i - \psi m$) between the wheel turn model direction ψm and the required direction ψi of the physical wheel housing. By one further multiplication the following term is obtained:

$\frac{1}{2}\sin 2(\psi i - \psi m) = \sin(\psi i - \psi m) \cos(\psi i - \psi m)$,
which identifies the double angular difference. Using this value as a command input to the wheel turn model, two stable and two unstable balance conditions are obtained:

The two stable ones are ($\psi i - \psi m$) = 0 and ($\psi i - \psi m$) = π, and
the two unstable ones are ($\psi i - \psi m$) = $\pi/2$ and ($\psi i - \psi m$) = $3\pi/2$.

This means, that the mathematical model and, consequently, also the physical wheel housing will line up either parallel to, or anti-parallel to the required direction ψi ,, whichever is the nearer.

This saves time and energy in the wheel turn motion, because the wheel turn housing will never need to turn more than an angle $\pi/2$ to attain any new required direction.
By subsequently multiplying the required wheel drive speed VWi , which is always a positive value, with the term $\cos(\psi i - \psi m)$ and use $\cos(\psi i - \psi m)VWi$ as the command value for wheel drive speed, it is ensured, that motion is always obtained in the correct direction irrespective of the choice between the two alignment possibilities.

Instead of directly using the term $\sin 2(\psi i - \psi m)$ as the command input to the wheel turn model, a modified version, which generates a linear variation around the two stable balance conditions up to a well-defined maximum value and suppresses actual zeroes at the unstable conditions.

WHEEL DRIVE COMMAND

As already mentioned, the term cos(ψi - ψm)VWi is applied as the input command. However, because the wheel tread is not moving along a trajectory traced out by centre axis of the wheel with its given co-ordinates, but at a trajectory offset from this by the amount of the wheel offset, another term ω'K4, where K4 is the wheel offset in meters, is subtracted from the wheel speed command. This compensates for the wheel tracing out a curve of a slightly modified radius in a turning condition. Further the command is subject to some inhibit and acceleration constraints as a tool to ensure smooth operation during varying operational conditions. The actual wheel drive servo is a digital/analogue system referring to up/down counts generated from a counter wheel directly on the motor shaft. The accumulated output counts are subtracted from similarly accumulated command counts, the resulting difference (positive or negative) converted into analogue form and given as the input to the power amplifier for the wheel drive motor M2.

The accumulated input counts result from a pulse rate generated in direct proportion to the finished wheel speed command cos(ψi - ψm)VWi - ω'K4 and subject to various inhibit conditions. The output counts from the counter wheel are duplicated into a monitor function, such that if the permissible mutual status of the photo read outs should be violated, a STOP condition is issued throughout the entire system and prevents any further driving.

LIMITING CONSIDERATIONS

Apart from the obvious limitations on speed, force and torque set by the control servos involved, a drive system of this nature requires some further considerations.

As a result of combined drive and turn movements of the total system, either wheel may get into the situation of receiving a drive command which reduces in magnitude towards zero, passes through or very near to zero and again increases in the opposite direction. If this takes place exactly through zero, this particular configuration is able to cope, as the drive command just goes through zero and then comes up again opposite without changing the orientation of the wheel housing. However, in most cases the command will just miss the exact zero point by a small amount, in which case the wheel housing, because of the polar co-ordinate nature of the wheel system, will be called upon to turn very fast in order to follow the actual command around.

If the limits of this capability are exceeded, jerks will be experienced in the drive motion of the total system. For this reason it is advantageous to set up restrictions of the fundamental command group (J'x , J'y , ω' , s'y), such that VWi cannot get below a certain

value if U' > VWi . Such conditions can be set up in various ways, the details of which will be related to the actual application of the drive system.

The following could be chosen as an example:
If (VWi < VWi,min) ^ (U' > 2VWi,min); then [J'x + 2VWi,mincosψi , J'y + 2VWi,minsinψi]; else [J'x, J'y];
where VWi,min is a minimum value of VWi below which uncertainties in the orientation determination of the wheel housing may become unacceptable.

It should be understood that various modifications and amendments of the wheel drive system described above and shown in the drawings could be made without departing from the scope of the following claims. As an example, the omni drive wheels used could be of any known type other than that described, and the central control unit as well as the electronic bogie control devices 3 could be modified as long as a similar function is performed.

CLAIMS

1. A drive wheel system for supporting and driving an object, said wheel system comprising:

at least two separate wheeled units or bogies to be mounted at selected locations on the object to support the same, each unit or bogie including a frame, at least one wheel member rotatably mounted in relation to the frame, driving means for rotating the wheel member(s) in relation to the frame, and steering means for moving the wheel member(s) in desired directions in relation to the frame, and

electronic control means for controlling the function of the driving and steering means of said wheeled units or bogies and including

a pre-programmed bogie control device at each said wheeled units or bogies, signal transmitting means, and a pre-programmed central control unit for outputting command signals to each of the pre-programmed bogie control devices via the signal transmitting means in response to input command signals received.

2. A system according to claim 1, wherein the central control unit comprises first programming means for inputting information about the mutual positions of the wheeled units or bogies on said object.

3. A system according to claim 1 or 2, wherein each bogie control device comprises second programming means for inputting information about the orientation of the associated wheeled unit in relation to a selected common axis when mounted on said object.

4. A system according to any of the claims 1 – 3, further comprising a command device for inputting command signals to the central control unit.

5. A system according to claim 4, wherein the command device comprises a manually operable steering device, such as a joystick, a steering wheel and/or one or more steering levers, or a system of force transducers.

6. A system according to claim 4, wherein the command device comprises remote control, such as e-mail or mobile phone.

7. A system according to any of the claims 1-6, wherein the signal transmitting means comprise galvanic isolating device.

8. A system according to claim 7, wherein the galvanic isolating device comprises an optocoupler.

9. A system according to any of the claims 1 - 8, wherein the central control unit comprises means for transforming output command signals to be transmitted to the bogie control devices at the wheeled units or bogies into serial digital strings.

10. A system according to any of the claims 1 - 9, wherein the electronics of the electronic control means is divided between the central control unit on one hand and each of the bogie control devices on the other hand so as to minimize data transmission via the signal transmitting means.

11. A system according to any of the claims 1-10, wherein the driving and steering means of the wheeled units or bogies comprise motors selected from the group consisting of electric motors, hydraulic motors, pneumatic motors, steam engines thermodynamic engines and combustion engines.

12. A system according to any of he claims 1-11, wherein the wheeled units or bogies of the system are substantially identical.

13. A system according to any of the claims 1-12, wherein each wheel member is of the type comprising a support member, a wheel element and a drive shaft, the drive shaft having a drive means engaging a drive surface on the wheel element to rotatably drive the wheel element relative to the support member, the drive shaft having a longitudinal axis and the engagement of the drive means and drive surface defining in vertical cross-section a line of engagement that is at an acute angle to the longitudinal axis, the wheel element having a surface contacting portion extending about its periphery and positioned such that it is intersected by the line of engagement substantially at where it contacts a supporting surface.

14. A system according to claim 13, wherein the drive shaft is substantially normal to the supporting surface.

15. A system according to claim 13 or 14, wherein the line of engagement is at an angle of between about 10° and 25° to the substantially normal longitudinal axis of the drive shaft.

16. A system according to any of the claims 13 - 15, wherein the support member has a substantially hemispherical outer surface with the wheel element rotatable about an axle extending normal to an inner surface of the hemispherical member.

17. A method of rendering an object self-propelling by means of a drive wheel system according to claim 2, 3 and 4, said method comprising:

mounting at least two of said wheeled units or bogies on the object at selected locations thereof and with selected orientations in relation to a certain direction,

programming said first programming means by inputting information about the mutual positions of the wheeled units or bogies on said object,

programming said second programming means by inputting information about the orientation of the associated wheeled unit in relation to a selected direction, and

inputting command signals to the central control unit by means of the command device so as to move the vehicle along a desired path.

18. A method according to claim 17, comprising basing the information about the mutual positions of the wheeled units or bogies in relation to an actual or imaginary co-ordinate system on said object.

19. A method according to claim 17, wherein said selected direction is one of the axes of the co-ordinate system.

20. A method according to any of the claims 17 - 19, wherein the electronic control means are pre-programmed to ensure that the steering means are moving all wheel members of the wheeled units or bogies mounted on the said object such that any time during driving all wheel members are either moving along substantially parallel lines or substantially concentric arcs of circles.

21. A method according to any of the claims 17 – 20, wherein the command signals are transmitted from the central control unit to the bogie control devices at the wheeled units or bogies as serial digital strings.

22. A method according to any of the claims 17 - 21, wherein the central electronic control unit is pre-programmed so that the wheeled object is driven along a selected path in accordance with such pre-selected program.

23. A method according to any of the claims 17-22, wherein the object to be rendered self-propelled is a manually driven vehicle having a plurality of supporting wheels, at least some of these wheels being replaced so as to have the vehicle supported by at least two of said wheeled units or bogies and freely swivelling wheels or casters, only.

24. A method according to any of the claims 17 - 23, wherein the central electronic control unit is mounted on the object

25. A method according to any of the claims 17 - 24, wherein a remote control device, such as e-mail or a mobile phone, is used as first programming means, second programming means and/or command device, and/or fault diagnosis means.

Abstract

A modular drive wheel system is used for supporting and driving an object so as to provide a power driven vehicle. The wheel system comprises two or more wheeled units or bogies (2) adapted to be mounted at selected locations of the object to support the same. Each unit or bogie (2) comprises one or more wheel members (1) mounted in the unit so as to be rotatable relative thereto. Motors (M) for rotating each wheel member of the unit and for steering the wheel member(s) of the unit or bogie in desired directions. The system further comprises a programmable central control unit (CPU) or microcomputer and a programmable electronic bogie control device (3) arranged at each of the wheeled units or bogies (2) for controlling the function of the driving and steering motors (M) of the wheeled unit(s) (2). Preferably, the central control unit and the bogie control devices (3) are galvanicly isolated, for example by means of optocouplers, and the control unit (CPU) may comprise means for transforming output command signals to be transmitted to the bogie control devices at the wheeled units or bogies into serial digital strings, whereby information may be transferred to the bogie control devices, for example via optocouplers (25), with high efficiency. Such modular system may be marketed as a standard wheel system for rendering any object, such as a load carrying platform or a vehicle, including wheeled hospital beds, self-propelling and extremely manoeuvrable.

Fig. 1

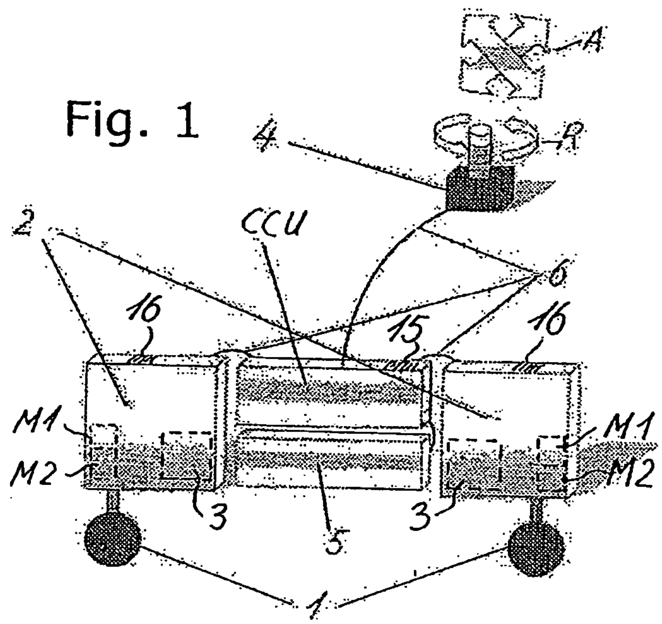


Fig. 3

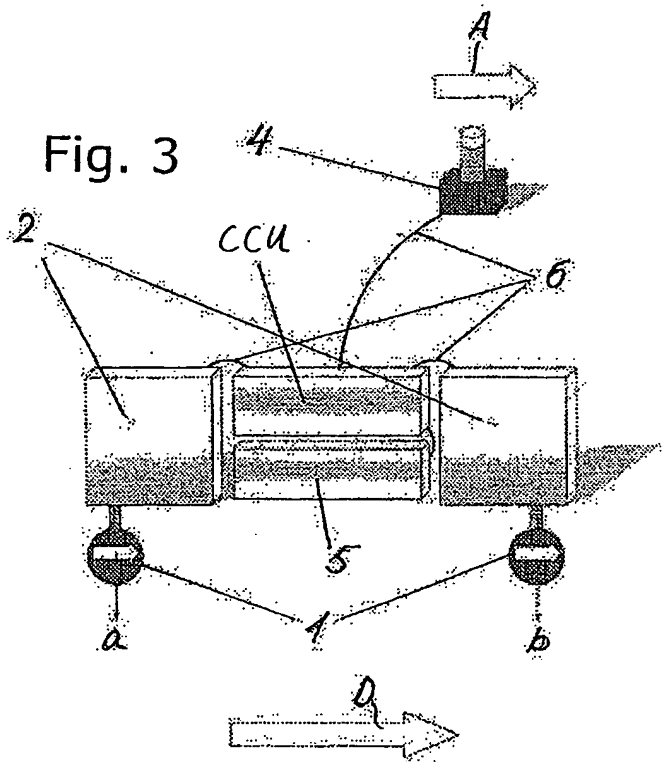


Fig. 2

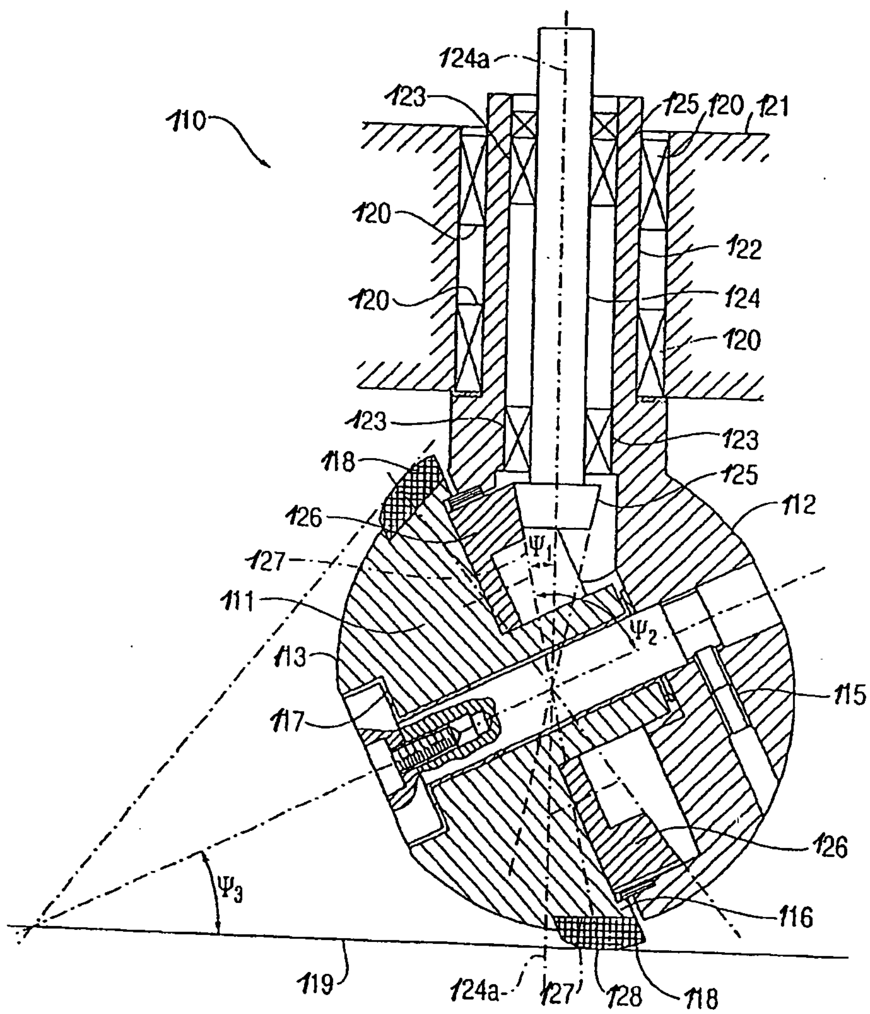

110
124a
123
125
120
121
122
124
118
126
112
127
Ψ1
Ψ2
111
113
115
117
Ψ3
116
119
128

Fig. 4

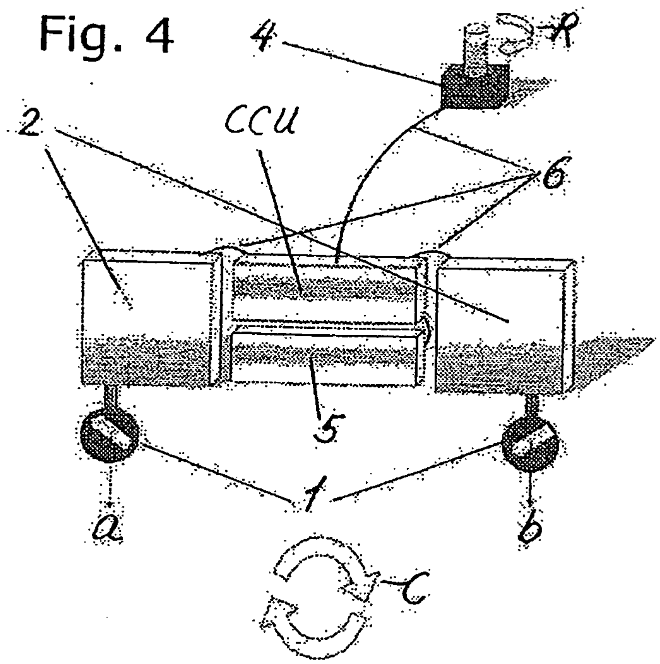


Fig. 5

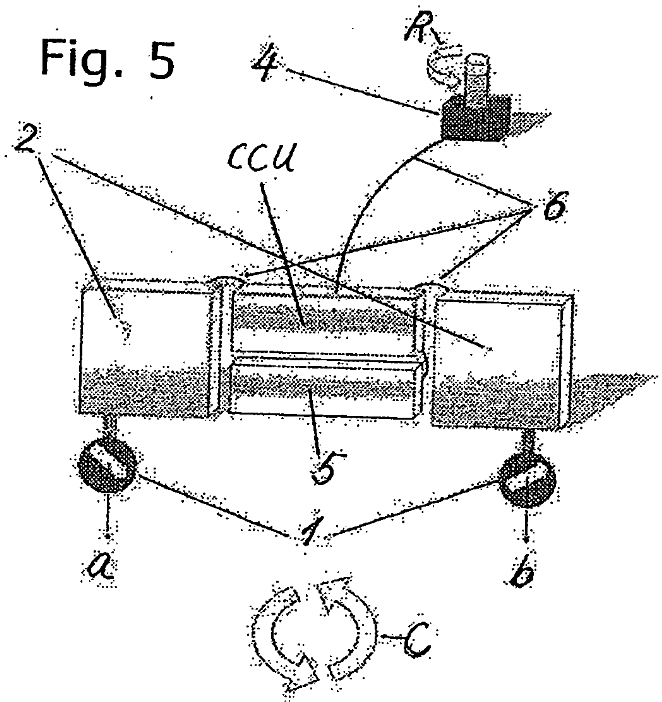


Fig. 6

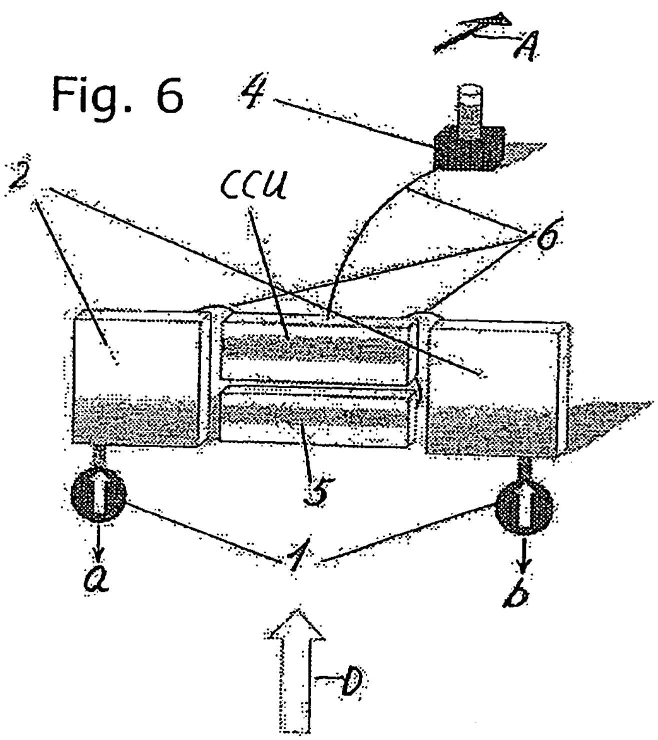


Fig. 7

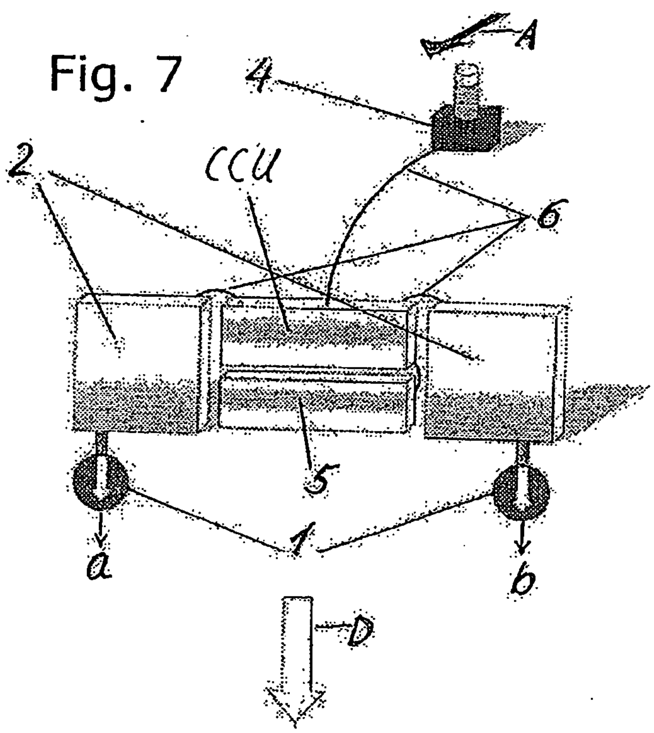
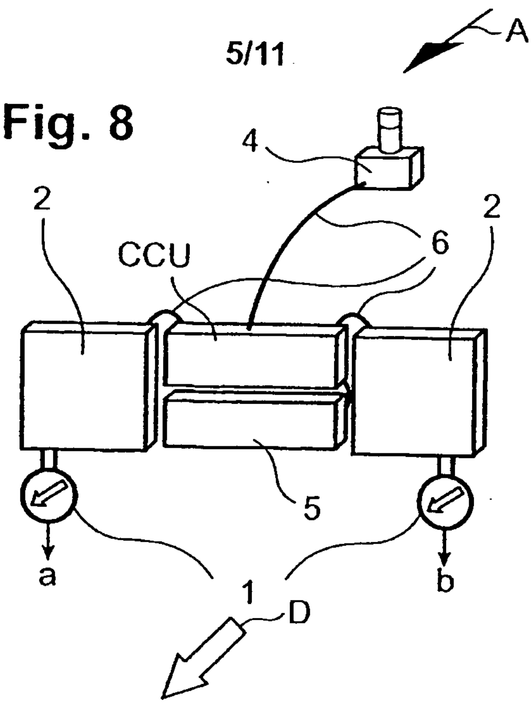


Fig. 8



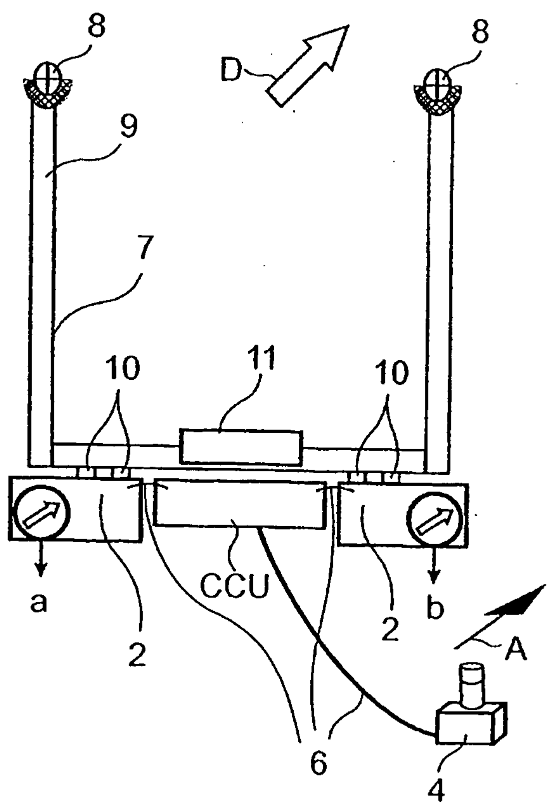


Fig. 9

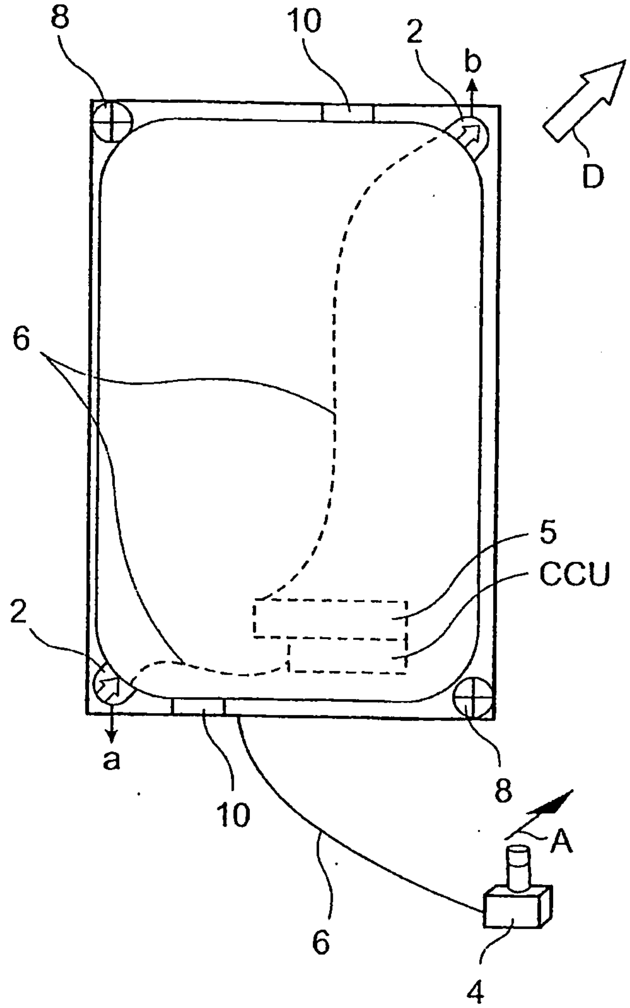


Fig. 10

Fig. 11

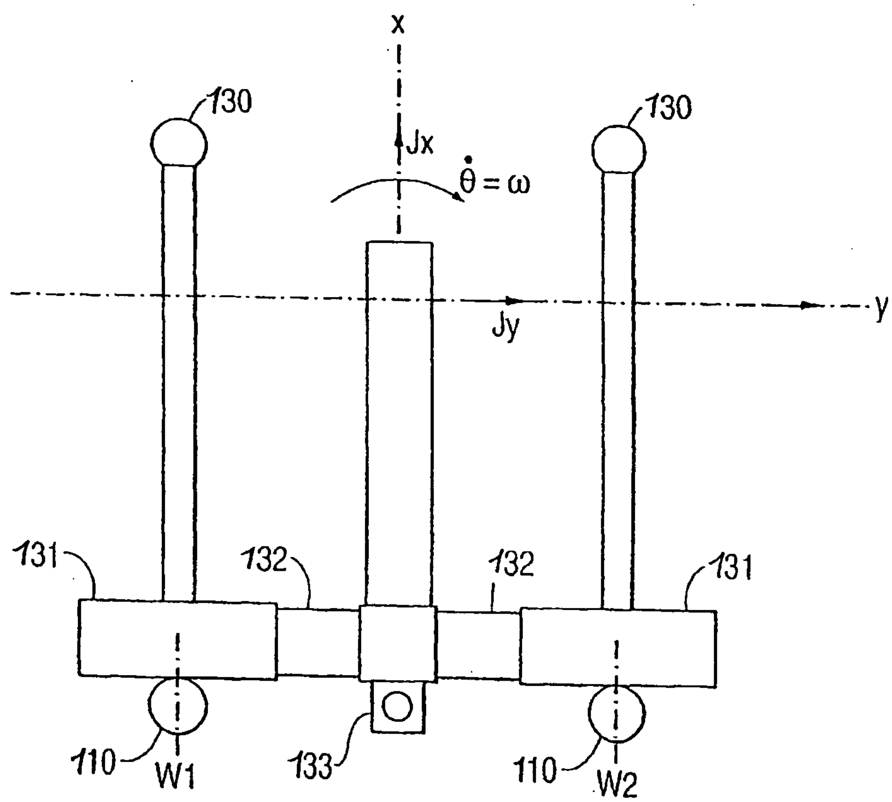
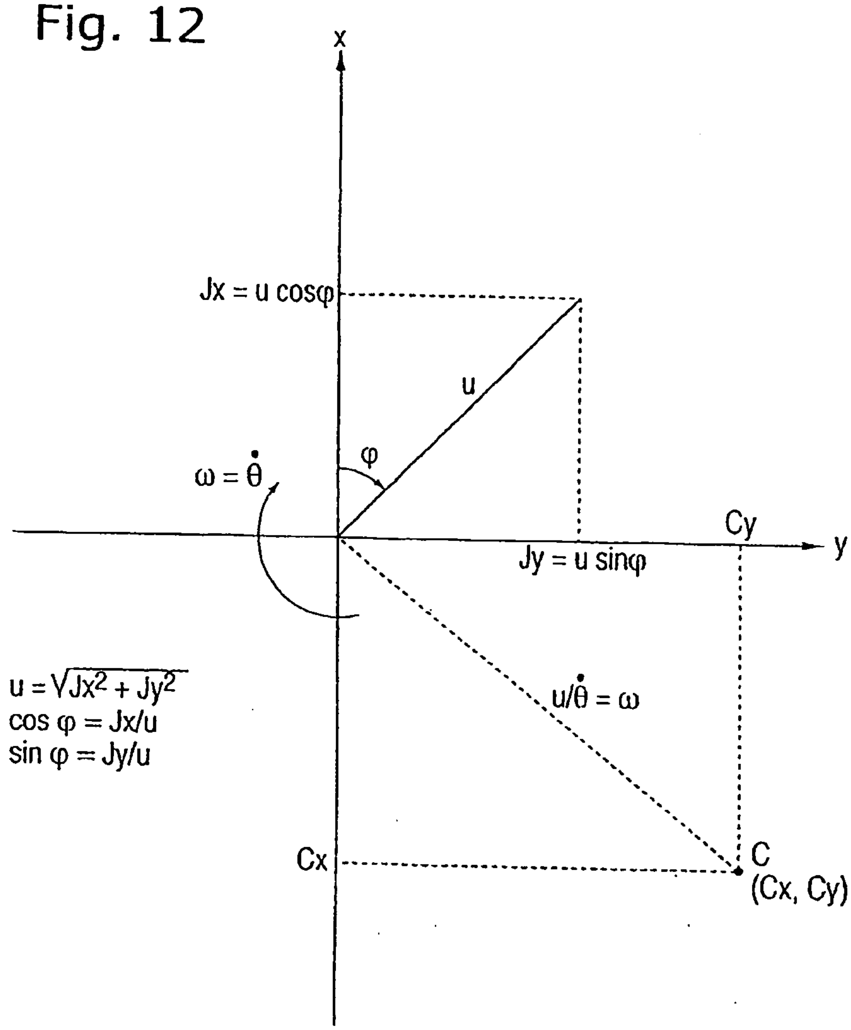

x
Jx
$\dot{\theta} = \omega$
y
Jy
130
130
131
132
132
131
110
W1
133
110
W2

Fig. 12



$$Cx = -\frac{u}{\dot{\theta}} \sin \varphi = Jy/\dot{\theta}$$
$$Cy = \frac{u}{\dot{\theta}} \cos \varphi = Jx/\dot{\theta}$$

CENTRE OF ROTATION

Fig. 13

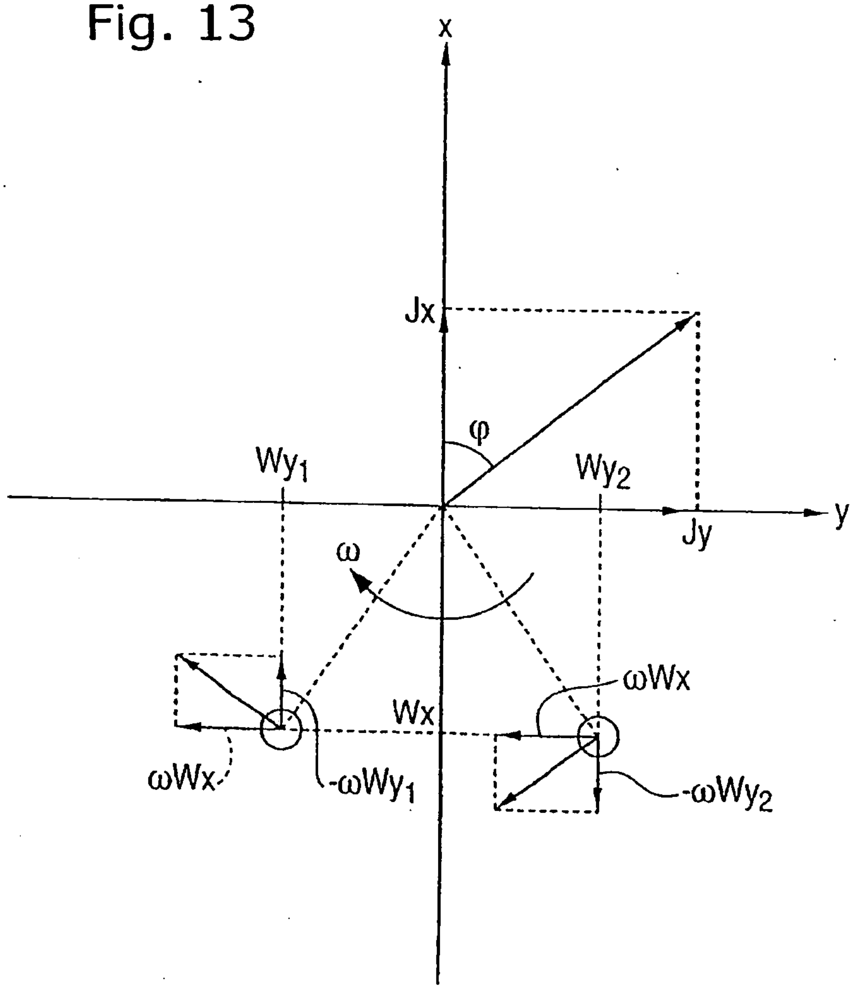
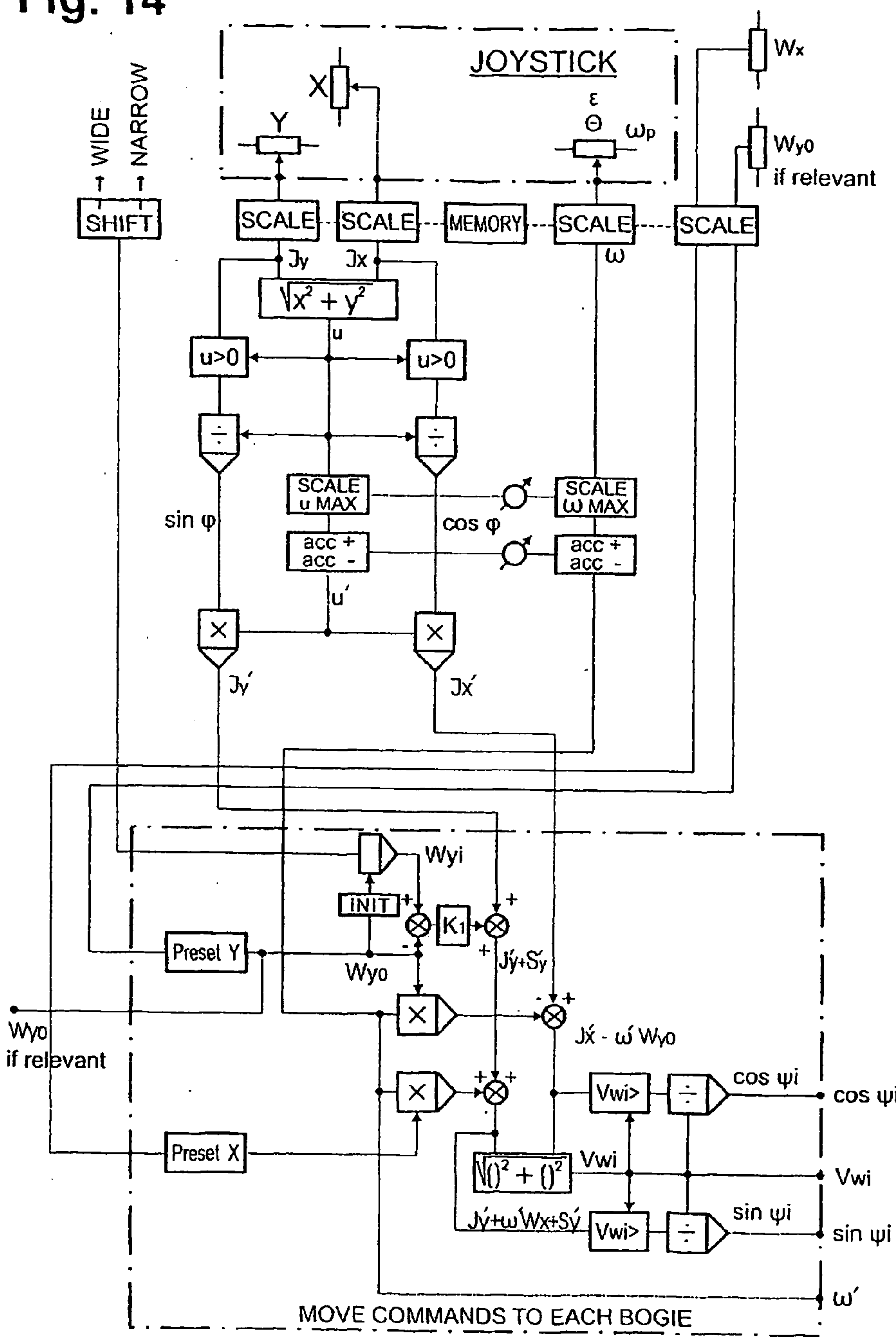
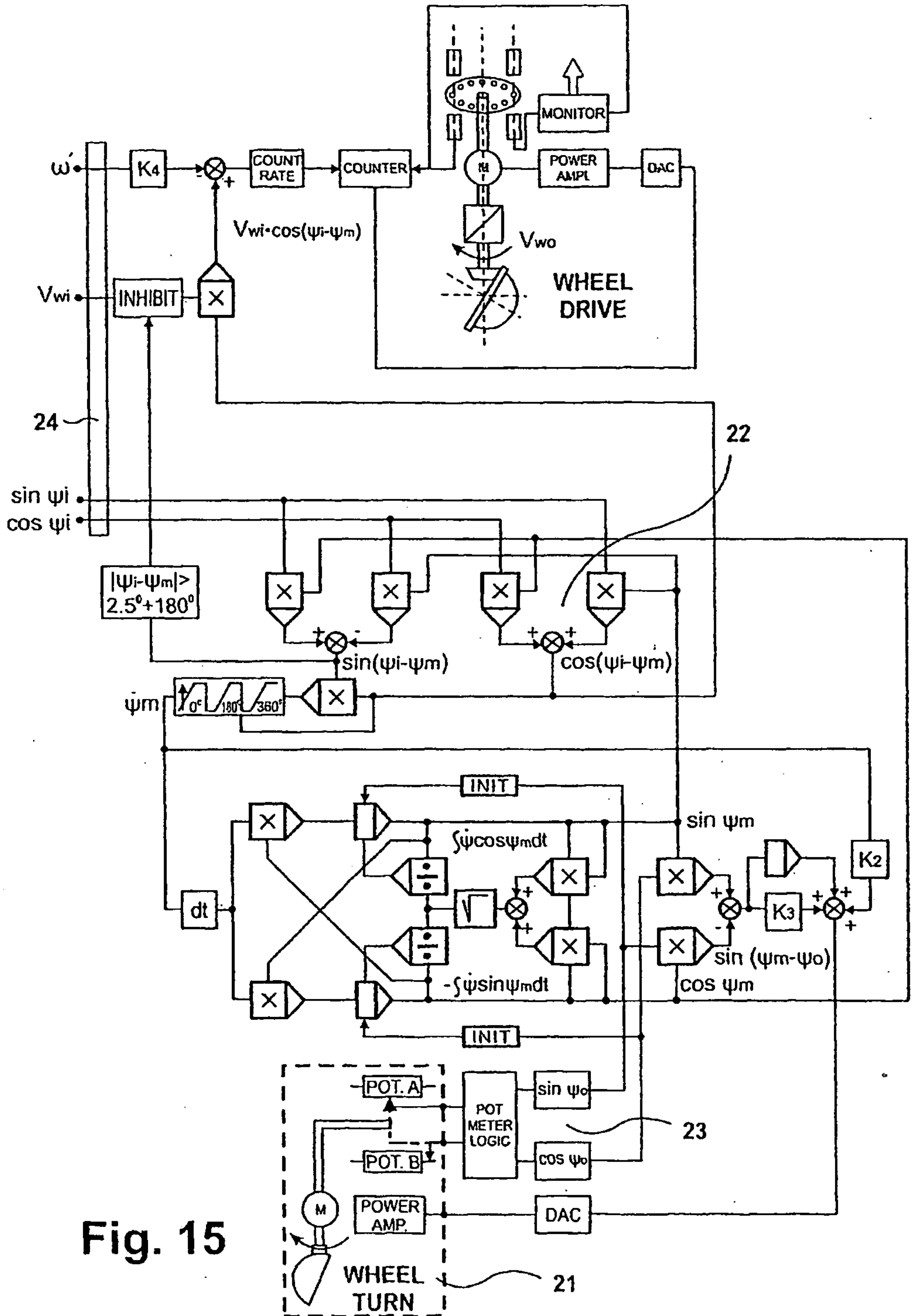


Fig. 14


JOYSTICK
X
Y
ε
Θ
ωp
Wx
Wy0
if relevant
WIDE
NARROW
SHIFT
SCALE
SCALE
MEMORY
SCALE
SCALE
Jy
Jx
ω
u
u>0
u>0
sin φ
cos φ
SCALE u MAX
SCALE ω MAX
acc + acc -
acc + acc -
u'
Jy'
Jx'
Wyi
INIT
K1
Jý+Sý
Preset Y
Wyo
Wyo
if relevant
Jx - ω' Wyo
Preset X
Vwi>
Vwi>
cos ψi
cos ψi
Vwi
Vwi
sin ψi
sin ψi
Jý+ω'Wx+Sý
ω'
MOVE COMMANDS TO EACH BOGIE



ω'
K4
COUNT RATE
COUNTER
MONITOR
POWER AMPL
DAC
Vwi·cos(ψi-ψm)
Vwo
WHEEL DRIVE
Vwi
INHIBIT
24
22
sin ψi
cos ψi
|ψi-ψm|> 2.5°+180°
sin(ψi-ψm)
cos(ψi-ψm)
ψm
0°
180°
360°
INIT
sin ψm
∫ψ̇cosψmdt
K2
dt
K3
sin (ψm-ψo)
-∫ψ̇sinψmdt
cos ψm
POT. A
POT METER LOGIC
sin ψo
23
POT. B
cos ψo
POWER AMP.
DAC
WHEEL TURN
21

Fig. 15

INTERNATIONAL SEARCH REPORT

International Application No
PCT/DK 03/00623

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60L15/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 038 500 A (WEISS HEINZ) 14 March 2000 (2000-03-14) the whole document ---	1
A	US 6 109 379 A (MADWED ALBERT) 29 August 2000 (2000-08-29) the whole document -----	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 March 2004	05 APR. 2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	MAGNUS WESTÖÖ/MN

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/DK 03/00623

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
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			AT	242134	T	15-06-2003
			DE	59808557	D1	10-07-2003
			EP	0864457	A2	16-09-1998
US 6109379	A	29-08-2000	AU	8662498	A	16-02-1999
			WO	9904998	A1	04-02-1999